

Tilburg University

The impact of labour flexibility and HRM on innovation

Zhou, H.; Dekker, R.; Kleinknecht, A.H.

Published in:
Innovation in business and enterprise

Publication date:
2010

Document Version
Publisher's PDF, also known as Version of record

[Link to publication in Tilburg University Research Portal](#)

Citation for published version (APA):
Zhou, H., Dekker, R., & Kleinknecht, A. H. (2010). The impact of labour flexibility and HRM on innovation. In L. Al Hakim, & J. Chen (Eds.), *Innovation in business and enterprise: Technologies and frameworks* (pp. 150-161). IGI Global.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Innovation in Business and Enterprise: Technologies and Frameworks

Latif Al-Hakim

University of Southern Queensland, Australia

Chen Jin

Zhejiang University, China

Director of Editorial Content: Kristin Klinger
Director of Book Publications: Julia Mosemann
Acquisitions Editor: Lindsay Johnston
Development Editor: Julia Mosemann
Publishing Assistant: Sean Woznicki
Typesetter: Deanna Zombro
Production Editor: Jamie Snavelly
Cover Design: Lisa Tosheff
Printed at: Yurchak Printing Inc.

Published in the United States of America by
Business Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: <http://www.igi-global.com/reference>

Copyright © 2010 by IGI Global. All rights reserved. No part of this publication may be reproduced, stored or distributed in any form or by any means, electronic or mechanical, including photocopying, without written permission from the publisher.

Product or company names used in this set are for identification purposes only. Inclusion of the names of the products or companies does not indicate a claim of ownership by IGI Global of the trademark or registered trademark.

Library of Congress Cataloging-in-Publication Data

Innovative in business and enterprise : technologies and frameworks / Latif Al-Hakim and Chen Jin, editors.

p. cm.

Includes bibliographical references and index.

Summary: "The focus of the book is on managing innovation through bridging gaps created from theories, relative advantages or competitiveness, social differences, and innovation capability and performance"--Provided by publisher.

ISBN 978-1-61520-643-8 (hardcover) -- ISBN 978-1-61520-644-5 (ebook) 1. Business enterprises--Technological innovations. I. Al-Hakim, Latif, 1946- II. Jin, Chen, 1968- III. Title.

HD2351.I556 2010
658.4'063--dc22

2009044408

British Cataloguing in Publication Data

A Cataloguing in Publication record for this book is available from the British Library.

All work contributed to this book is new, previously-unpublished material. The views expressed in this book are those of the authors, but not necessarily of the publisher.

Chapter 11

The Impact of Labour Flexibility and HRM on Innovation

Haibo Zhou

Erasmus University Rotterdam, The Netherlands

Ronald Dekker

Delft University of Technology, The Netherlands & Reflect at Tilburg University, The Netherlands

Alfred Kleinknecht

Delft University of Technology, The Netherlands

ABSTRACT

We investigate the impact of labour relations (including use of flexible labour and certain HRM practices) on a firm's innovative output. Using firm-level data for the Netherlands, we find that active HRM practices such as job rotation, performance pay, high qualification levels of personnel, as well as making use of employees with long-term temporary contracts contribute positively to innovative output, the latter being measured by the log of new product sales per employee. Furthermore, firms that retain high levels of highly qualified personnel are more likely to introduce products that are new to the market (other than only 'new to the firm'). Our findings contribute to the growing literature on determinants of innovative performance.

INTRODUCTION

It tends to be generally recognized that firms need to be innovative in order to sustain their competitive advantage (e.g. Brown and Eisenhardt, 1997; Cohen and Levinthal, 1990; Leonard-Barton, 1995; McGrath, 2001; Tsai, 2001). Innovation can be regarded as a business process which creates unique and perceptive ideas that are being pushed towards commercial success (e.g. Verloop, 2004).

With the increasing availability of firm-level data such as through the European Community Innovation Survey (CIS) exercise by the European Commission, econometric studies of determinants of innovative behaviour are growing in recent years. This literature focuses on determinants of innovation such as market structure, firm size, (regional and international) knowledge spillovers, R&D collaboration, conditions for appropriation of innovation benefits, and others. By lack of good data on firm level labour relations within the CIS questionnaire, there are only sparse studies on the latter. This is

DOI: 10.4018/978-1-61520-643-8.ch011

regrettable, as labour relations can be expected to have a significant impact on innovation, among others through their influence on knowledge processes (see e.g. David 1997, Trott 1998)

The role of personnel for enhancing creativity and innovation is also recognized by Amabile et al. (1996). An OECD (1997) study indicates that the key of the innovative process is the flow of technology and information among people, enterprises and institutions. Individuals are the carriers of knowledge. Among others, knowledge diffusion can take place via mobile personnel. Furthermore, literature on the impact of labour relations on innovation suggests that active Human Resource Management (HRM) policies might be rewarding for a firm's innovation and productivity growth (e.g. Kleinknecht et al., 2006; Verburg 2005). As empirical evidence is still sparse, we investigate the nexus between labour relations and innovative output by conducting an empirical study among firms in the Netherlands.

LABOUR RELATIONS IN THE NETHERLANDS

Among enterprises in the Netherlands, we find a fairly wide spectrum of different types of labour relations and HRM practices. One end of the spectrum covers typically 'Rhineland' enterprises with internal labour markets that offer their personnel good wages, fair protection against dismissal, and long-term commitments. The other end of the spectrum includes enterprises that follow Anglo-Saxon practices; the latter employ lots of labour on fixed-term contracts, labour hired temporarily from temporary work agencies or freelance workers, i.e. self employed entrepreneurs that have no personnel.

There is a strand of literature that suggests that 'Rhineland' practices are more conducive to labour productivity growth (e.g. Buchele and Christiansen, 1999 for evidence from macro data; Kleinknecht et al., 2006 for evidence from firm-

level data). The rationale is that a longer-term commitment between the firm and its employees may function as an investment into 'social capital'; i.e. into loyalty, trust and commitment. The latter will diminish the probability of opportunistic behaviour such as the stealing of a firm's properties or leaking to competitors of crucial trade secrets or new technological knowledge. Moreover, one can argue that, in a Schumpeter II innovation model, the quality of a firm's products and/or its efficient process performance crucially depends on the long-run historical accumulation of (incremental) technological knowledge. Much of this knowledge is 'tacit'. Other than publicly documented and codified knowledge, tacit knowledge is defined as 'un-codified', ill-documented and idiosyncratic; tacit knowledge is based on personal experience (e.g. Polanyi, 1966). The continuous and long-run accumulation of knowledge, and of 'tacit' knowledge in particular, is favoured by continuity in personnel, i.e. by keeping people in the firm for longer time periods. A longer stay with the same employer will also enhance a firm's readiness to invest in education and training.

Against this one can argue that 'Anglo-Saxon' practices might be favourable to a firm's innovation potential. With higher rates of labour turnover, firms have a high inflow of fresh people with new ideas, skills and networks. Moreover, less productive people can be more easily replaced by more productive ones, and the threat of firing might prevent shirking. Easier hiring and firing could also help to keep wages low and allow for a more flexible re-allocation of labour. Moreover, it has been argued that innovation might be difficult to implement among (long) tenured employees due to their lack of openness to new products and processes (e.g. Ichniowski and Shaw, 1995). From this viewpoint, one could argue that some flexibility of labour is needed for innovation, especially for radical innovation.

Labour Flexibility and Innovative Output

Flexibility of labour can be categorized into three types, i.e. numerical flexibility, functional flexibility and wage flexibility (e.g. Beatson, 1995; Michie and Sheehan, 2003). In the following, we focus on numerical and functional flexibility. Numerical flexibility is defined as the ability of firms to change the volume of personnel by making use of fixed-term employment contracts, labour hired temporarily, either directly or through temporary work agencies or freelance workers. Numerical flexibility relates to the possibility of responding quickly to changes in demand by easy hiring or firing of personnel through the external labour market. Functional flexibility is the ability of firms to re-allocate labour in their internal labour market, relying on training that allows personnel carrying out a wider range of tasks (e.g. Beatson, 1995; Michie and Sheehan, 2003). Indicators of numerical flexibility are percentages of people on temporary contract, labour hired from temporary work agencies, freelance workers or general labour turnover (i.e. percentages of people that join or leave the firm). An indicator of functional flexibility is the internal labour turnover, i.e. percentages of people that change function or department within the firm.

Ichniowski and Shaw (1995) show that long tenured employees may be conservative to outdated products and processes; it may be difficult for them to accept changes and it may require more money and time for them to adapt to a significant change. Innovation will be difficult to implement with them. Therefore, to a certain extent, external labour turnover is needed by firms; it can stimulate innovation, especially radical innovation.

A high external labour turnover, however, may harm the firms' stability and the continuity of learning. High frequency of hiring and firing of people will de-motivate employees and diminish trust, loyalty and commitment to their firms. As a consequence, productivity gains will be lower.

High external labour turnover will make it difficult for firms to store innovative knowledge, in particular of 'tacit' knowledge that is attached to individuals. At the same time, firms will hesitate to make investments in manpower training. Coutrot (2003) investigated the relationship between innovation and job stability with the data from the REPONSE ("Industrial relations and firm negotiations") surveys. Although his hypothesis was that there would be a negative correlation between the intensity of innovation and labour turnover, his econometric analysis does not confirm this. Based on earlier studies (e.g. Coutrot, 2003; Ichniowski and Shaw, 1995), one could argue that external labour turnover has a positive effect on innovative output, becoming negative beyond some optimal point.

Internal labour turnover is measured by percentages of employees that are reassigned and rehired inside the firm during a year. Internal labour turnover can reduce hiring and training costs, improve employee morale and motivation, and reduce the effect of uncertainty. Internal labour turnover also gives chances to employees to develop their career inside a firm. Often, internal labour turnover concerns employees in higher positions, i.e. mainly core employees. They typically have higher levels of knowledge and/or experience. By retaining them, firms can sustain their competitive position and ensure the success of their innovation projects. Furthermore, communication barriers between different departments can be reduced by reassigning and reallocating labour inside the firm. It will decrease the number of misunderstandings in future cooperation on innovation projects and increase knowledge sharing and transfer between different departments, thereby stimulating the process of generating organizational knowledge which is favourable for incremental innovation. We therefore expect internal labour turnover to have a positive impact on innovative output.

Human Resource Management Practices and Innovative Output

The aim of human resource management (HRM) is to create and enhance the competitive advantages of firms by recognizing the human resources inside firms (e.g. Verburg and Den Hartog, 2005). Bratton and Gold (2003) define that “human resource management is a strategic approach to managing employment relations which emphasizes that leveraging people’s capabilities is critical to achieving sustainable competitive advantage, this being achieved through a distinctive set of integrated employment policies, programmes and practices” (p. 3). The process of HRM embraces three phases: entry, performance and exit of employees while HRM practices play crucial roles in the whole process (e.g. David, 1997).

For innovative firms, hiring knowledgeable and creative people who can bring ideas and skills into the firm will directly affect innovative performance. A mistake in a hiring decision will not only cause more expenditure on recruitment processes but also slow down innovation projects due to a lack of qualified people. Recruitment and selection requirements such as education and experience are important for finding the right people for the right position. In general, firms would like to hire highly educated or more experienced people because they have the capability to independently learn new knowledge and skills. Compared to low educated or less experienced employees, they can quickly adapt to a changing environment. Therefore, we suggest that a higher number of highly qualified employees with the appropriate educational background and sufficient experience will contribute positively to innovative output.

Performance management concentrates on evaluating, motivating and developing employees’ capabilities and performance in order to improve the effectiveness and efficiency of firms. Appraisal, reward and career development systems are main activities of performance management (e.g. Verburg and Den Hartog, 2005). The reward

system can be made up with both financial and non-financial incentives. The financial reward system includes competitive wage, financial compensation for hard working, rewards for learning new skills, knowledge and contributing innovative and creative ideas. The non-financial reward system includes employee care facilities such as child-care and health centres, opportunities abroad and work mobility. A competitive reward system is defined by horizontal comparison with other firms and has been argued that it can stimulate employees’ performance and organizational learning processes. Laurens & Foss (2003) investigate the interrelation between complementarities of HRM practices and innovative performance. Using data from a Danish survey of 1900 business firms, they found that reward systems such as variable pay systems and internal mobility practices will motivate skilled employees to contribute and share their knowledge. Eventually this will be conducive to innovative performance. Similarly, we suggest that incentives within the competitive reward system such as job rotation and performance pay will have a positive effect on innovative performance.

DATA AND VARIABLES

In this study, we use firm-level data collected by the *Organisation for Strategic Labour Market Research (OSA)* in the Netherlands. OSA is sampling all organizations in The Netherlands that employ personnel, with a minimum of five people. Organizations that have taken part in the survey in previous years are again approached for the next survey. Data collection is done by a combination of face-to-face interviews and a written questionnaire to be filled in by a manager and returned by mail. For this chapter, we use data from the 2001 survey, which contains information on the period 1998-2000 for 1482 commercial establishments, covering all manufacturing and commercial service sectors.

Dependent Variables

For a test of the impact of flexible labour and HRM practices on innovative output, the OSA database offers a wide range of interesting indicators. The respondents were asked to subdivide their present product range into three types of product in the OSA Survey:

1. Products that remained *largely unchanged* during the past two years;
2. Products that were *incrementally improved* during the past two years; and
3. Products that were *radically changed* or introduced *entirely new* during the past two years.

Subsequently, firms are asked to report the share of these three types of product in their last year's total sales. That is the definition of innovative output in this chapter. This definition is also relevant for companies with a small number of products in their portfolio, because the definition is based on the turnover share, not on the number of products.

As dependent variables, we use:

- The log of sales per employee from products 'new to the firm' (introduced during the past 3 years) in year 2000 and
- A categorical variable measuring to what extent new products are 'new to the market'.
 - Hardly new to the market
 - Partially new to the market
 - Completely new to the market

To construct the log of new product sales per employee, we add up categories (2) and (3), i.e. incremental and radical innovations. One should note that the new product sales according to definition (2) and (3) need to be novel in that they include new technological knowledge or, at least, they should be based on novel (and

creative) combinations of existing technological knowledge. The products under (2) and (3) can include products that are new to the *firm* (already known in the market) or products that are first in the *market*. In a subsequent question, firms are asked to grade the newness of their present products on a 3-point scale, ranging from 1 'hardly new to the market' to 3 'completely new to the market'.

Independent Variables

Explaining a firm's score on the log of 'new product sales per employee' and the newness of these products, we use a number of labour relations indicators. The latter include shares of flexible labour and specific HRM practices as independent variables, besides a number of control variables. Descriptive information on these variables is presented in Table 1.

Indicators of flexible labour include proxies for external flexibility (percentages of workers on temporary contracts) and internal labour flexibility. HRM practices include proxies for recruitment and selection practices measured by the educational level of the workforce (percentage of workers with higher education). Furthermore we include two dummy variables as proxies for a competitive reward system: job rotation and performance pay. In principle, we expect the six independent variables in the table to have a positive impact on volumes of sales of innovative products as well as the degree of innovativeness, although the impact of temporary contracts might be ambiguous. On the one hand, short-term commitments might undermine loyalty of workers and the continuity in knowledge accumulation. On the other hand, lots of highly educated people are, notably in their first job, hired on a temporary basis, often with a perspective of tenure. Moreover, specialist technical and commercial consultants can often be hired on a temporary basis. We make a distinction between short-term and long-term temporary hiring, the division line being 9 months of contract. We would expect that

Table 1. Description of variables

| Variable name | Variable description | Mean |
|--|--|-------|
| <i>Dependent variable (Innovative output)</i> | | |
| Innovation productivity | Log of new product sales per employee | 3.93 |
| Innovativeness | Was the new product new for the market, partially new for the market or hardly new for the market? | 1.82 |
| <i>Independent variable (Labour flexibility)</i> | | |
| High external flexibility | Share of workers on temporary contract*short-term contracts (<9 months are more important); cross dummy | 0.86 |
| Low external flexibility | Share of workers on temporary contract*longer-term contracts (>9 months are more important); cross dummy | 1.58 |
| Internal flexibility | Percentages of workers that changed their function and/or department within the firm | 2.85 |
| <i>Independent variable (HRM practices)</i> | | |
| Highly qualified personnel | Percentages of workers with university or higher professional education degrees | 13.33 |
| Performance pay | Dummy: Firm has systems of performance pay (e.g. profit sharing arrangements) | 0.48 |
| Job rotation | Dummy: Firm employs job rotation systems | 0.69 |
| <i>Control variables</i> | | |
| IT infrastructure | Dummy: Firm uses internet or will have internet access within two years | 0.91 |
| Communication technology | Dummy: Organization introduced new logistic or ICT processes in the last 2 years | 0.19 |
| R&D intensity | Percentage share of turnover spent on Research & Development | 2.18 |
| Small size firm | Dummy: number of employees is between 5 and 49 | 0.58 |
| Medium size firm | Dummy: number of employees is between 50 and 249 | 0.27 |
| Large size firm | Dummy: number of employees is 250 and 499 | 0.07 |
| Industry average new product sales | Average of logs of new product sales per employee in a firm's sector of principal activity | 3.91 |

notably when hired on a longer-run basis, such people may positively add to innovative output, even if hired only temporarily.

Control Variables

Our three most important control variables include:

1. A firm's R&D intensity. Of course, if there is more R&D input, we expect there to be more innovative output.
2. Firm size. Small firms have advantages such as little bureaucracy, short communication lines, or dedicated management by the owner.

The literature also reports, however, typical shortcomings of the innovation process in small firms: A strong dependence on the owner as a key person; or a chronic lack of financial and other resources (e.g. technological knowledge; see Tidd et al., 2006). In smaller firms, the innovation process often is a zero/one decision: failure of a single project can mean the end of the firm, while success can mean exceptional growth. Larger firms also have the advantage that they can maintain larger portfolios of risky projects, thus diminishing their innovative risks by means of diversification.

3. Industry average of new product sales: A firm's score on the dependent variable (log of new product sales per employee) crucially depends on the typical length of the product life cycle in a firm's sector of principal activity. Obviously, sectors with typically short product life cycles (such as food or fashion) will have higher rates of new product introductions (and higher sales of new products) than sectors with long life cycles such as aircraft production. The dependent variable can therefore not be compared across sectors, unless we correct for life cycle differences. As life cycle data are not easily collected in postal surveys, we use, as a substitute, the log of average new products sales in a firm's sector of principal activity. Besides correcting for typical differences in product life cycles between sectors, this variable can also pick up other unobserved specifics of sector. Not surprisingly, inclusion of this variable made sector dummies insignificant. Besides, we also include dummies for a firm's focus on information and communication technologies which is an indication of high technological opportunities.

METHODOLOGY

The Tobit model is suitable for analysing the relationship between a dependent variable y_i and a vector of independent variables x_i , where the domain of the dependent variable is restricted between a lower (left-censoring) and an upper (right-censoring) bound (e.g. Tobin, 1958). The model suggests a linear dependence of a latent variable on x_i via a parameter (vector) β . The disturbance terms, u_i , follow a normal distribution to capture random influences on this relationship. In this chapter we use a version of the Tobit model with only a lower bound, the observable variable y_i is defined to be equal to the latent variable whenever the latent variable is above zero and zero other-

wise. In order to have a consistent estimator for the parameter β , a maximum likelihood estimator has been suggested (e.g. Amemiya, 1973). The mathematical representation of a simple Tobit model is as follows:

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases}$$

Where y_i^* is a latent variable

$$y_i^* = \beta x_i + u_i, u_i \sim (0, \sigma^2)$$

We use a Tobit procedure (e.g. Maddala, 1985) in this chapter to correct for the specific non-normality of the distribution of our dependent variable (log of 'new product sales per employee'). This non-normality stems from the relatively large number of firms that have zero new product sales. These are the left-censored observations in the Tobit output. Our empirical tobit model is formulated as follows:

Model 1:

$$y_i = \alpha + \beta_1 LF + \beta_2 HR + \beta_3 Con + \varepsilon_i$$

Where y_i denotes the log of 'new product sales per employee'; 'LF' includes variables of external flexibility measured by percentages of temporary workers and internal flexibility measured by percentage of employees changing function/department within firms; 'HR' are variables of HRM practices including percentage of highly qualified personnel, dummies for job rotation and performance pay; 'Con' represents control variables. The disturbance term ε_i follows a normal distribution.

We apply an *Ordered Logistic Model* for analysis of determinants of the degree of innovativeness. It can be regarded as an extension of the logistic regression model for dichotomous dependent variables. It is also referred to as ordered

logit and ordered-response model (e.g. Maddala, 1983). The econometric logic behind this model is a linear relationship between a latent continuous variable y_i^* ($i=1, \dots, n$) and the independent variables X_i , $y_i^* = \beta X_i' + \varepsilon_i$, where the disturbance term ε_i follows a logistic distribution with fixed variance at $\pi^2/3$ with zero means. We use the observed variable y_i to estimate the parameter β of equation explaining latent y_i^* . Corresponding to each observed variable y_i ($y_i = 1, \dots, J$), the latent variable y_i^* can be divided by some unobserved threshold $\alpha_1, \dots, \alpha_{J-1}$. It can be illustrated as $\ln(\Theta_j) = \alpha_j - \beta X$ and $\Theta_j = \text{prob}(y_i \leq j) / \text{prob}(y_i > j)$, ($j=1, \dots, J-1$). The results of the Ordered Logistic Model can be interpreted by 'log-odds ratios'. Given a positive coefficient and holding constant all other variables, an increase in a particular variable raises the likelihood of moving to a higher engagement level comparing to the present level (e.g. Van der Zwan, 2008). Our Ordered Logistic Model is formulated as follows:

Model 2:

$$\ln \left(\frac{\Pr(Y_1 = j)}{\Pr(Y_1 = j-1)} \right) = \alpha + \beta_1 LF + \beta_2 HR + \beta_3 Con + \varepsilon_j$$

($j=2$ or 3)

where Y_j denotes the degree of innovativeness measured by 3-point Likert-type scale; 'LF' includes variables of external flexibility measured by percentages of temporary workers and internal flexibility measured by percentages of employees changing function or department within the firm; 'HR' covers HRM practices, including percentage of highly qualified personnel, dummies for job rotation and performance pay; 'Con' represents control variables.

RESULTS

Our regression estimates are summarized in Table 2. In the Tobit Model (Model 1), we explain the

log of new product sales (per employee) achieved by firms that have such sales. In other words, our interpretation is strictly confined to the group of innovating firms among the respondents to the OSA survey. It is no surprise that R&D intensity has a positive impact on innovative output, which is significant at a 5% level. Processes related to a firm's innovativeness such as the introduction of new logistic or ICT processes are, as expected, positively (at a 5% significant level) related to innovative productivity. Not surprisingly, we find that an individual firm's innovative output depends on the average output of its sector of principal activity (at a 5% significant level). Inclusion of the latter variable implies that our model explains a (positive or negative) deviation of an individual firm's new product sales from its sector average. As to firm size, we have to conclude that the typical advantages or disadvantages of a firm being small or big seem to cancel out each other: there is no difference in sales of innovative products across size classes.

Furthermore, we can conclude that most of our variables on flexible labour and on HRM practices behave as expected. High shares of highly qualified personnel enhance innovative productivity, although this is only significant at a 10% level. The same holds for job rotation. Moreover, performance pay (including profit sharing arrangements) is positively related to innovative productivity (at a 5% significant level). This reflects the practice that firms give financial incentives to qualified people in order to keep them in the firm, rather than letting them leave and take along their (tacit) knowledge to competitors. To our surprise, however, a high rate of internal ('functional') flexibility does not seem to contribute to innovative output. In related estimates, we found that high internal flexibility did contribute to overall sales growth, notably among innovating firms (e.g. Kleinknecht et al. 2006). As to people on temporary contracts, it is interesting to note that higher shares of people with longer contracts (> 9 months) have a weakly significant positive impact on innovative

Table 2. Summary of estimates

| Dependent variable | Model 1 (Log) sales per employee of products new to the firm | | Model 2 Probability of having products new to the market (other than new to the firm) | |
|---|--|---------------------|--|----------|
| Variables for flexible labour: | Coefficients | t-values | Odds ratio | t-values |
| High external flexibility | 0.100 | 1.39 | 0.005 | 0.45 |
| Low external flexibility | 0.091* | 1.73* | 0.005 | 0.83 |
| Internal flexibility | -0.017 | -0.24 | 0.002 | 0.30 |
| HRM practices variables: | | | | |
| Highly qualified personnel | 0.042* | 1.89* | 0.004** | 1.96** |
| Performance pay | 2.500** | 2.58** | 0.114 | 0.87 |
| Job rotation | 1.703 ^(*) | 1.61 ^(*) | -0.000 | 0.00 |
| Control variables: | | | | |
| IT infrastructure | 6.631** | 3.32** | 0.077 | 0.28 |
| Communication technology | 3.847** | 3.18** | 0.257* | 1.73* |
| R&D intensity | 0.311** | 3.46** | 0.025** | 2.57** |
| Small firm | 0.475 | 0.23 | -0.443** | -2.13** |
| Medium-sized firm | 0.169 | 0.08 | -0.390* | -1.76* |
| Large firm | 1.707 | 0.62 | -0.147 | -0.51 |
| Industry average new product sales | 2.168** | 4.08** | 0.022 | -0.25 |
| Constant term | -22.401** | -5.98** | | |
| /cut1 | | | -0.830 | |
| /cut2 | | | 1.760 | |
| | 335 uncensored observations; 565 censored observations LR chi2(13) = 93.04 (Pr > χ^2 = 0.0000) Log likelihood = -1623.9698 Pseudo R ² = 0.0278 | | 1014 observations; LR chi2(13) = 26.17 (Pr > χ^2 = 0.0161) Log likelihood= -979.3277 Pseudo R ² = 0.0132 | |
| (*) Coefficient just fails to be significant at 10% level * = significant at 10% level ** = significant at 5% level | | | | |

productivity (at a 10% significant level), while higher shares of people on shorter contracts do not contribute significantly. In an alternative version of our estimate (not documented here) we found that high rates of temporary contracts (without distinction by contract length) had a significant positive impact on innovative performance. This gives some support to the above-quoted argument by Ichniowski and Shaw (1995).

Results from the Ordered Logistic Model (Model 2) show that high shares of ‘highly quali-

fied personnel’ have a positive impact on the degree of innovativeness (significant at 5% level). Neither flexible labour nor reward systems influence the degree of innovativeness. It is no surprise again that R&D intensity is also positively related to a higher degree of innovativeness (at a 5% significant level). Furthermore, introducing new logistic or ICT processes has a weak positive impact on the degree of innovativeness (at 10% level). Seemingly, communication technology (new logistic or ICT processes) or IT infrastructure (internet

access) contribute to the efficiency of innovation processes. High shares of new product sales (new to the firm) at the sector level have no significant impact on the probability of introducing products new to the market. However, firm size seems to matter. The smaller the firm, the less likely are innovations ‘new to the market’.

CONCLUSION AND IMPLICATIONS

We examined the impact of labour relations on innovative output, distinguishing two sorts of innovative output: (1) Innovative productivity: measured by the logs of new product sales per employee (i.e. products new to the firm, other than new to the sector) and (2) Innovativeness: measured by the probability that new products are new to the market (and not only new to the firm). Our labour relations indicators differ in their contribution to the two different dimensions of innovative output. The only robust indicator is highly qualified personnel which has a positive impact on both sales of innovative products as well as on the probability that new products will be ‘new to the market’. This underlines the role of human capital to the innovative process. Highly educated employees allow for high learning capabilities, high absorptive capacity, and high analytical and problem-solving abilities, which tend to be individualized and tacitly embedded.

Further, we find strong indications that active HRM practices, including job rotation and performance pay do contribute positively to sales of innovative products, while the impact of flexibility remains ambiguous. We should add that the model estimated in Table 2 is fairly robust to small model changes (e.g. replacing our size class dummies by a continuous variable). We also experimented with quadratic terms, finding only little evidence of non-linear relationships. An important qualification of our findings is that we use cross-sectional data only. This did not allow introducing time lags between our exogenous

and endogenous variables. This implies that one should be extremely cautious with causal inferences. Future research should include the use of longitudinal data which will, however, lead to a substantial loss of observations due to panel attrition.

While some of our findings are in favour of the view that ‘Rhineland’ practices may support innovative performance, the evidence is not clear-cut. On the one hand, we find that systems of job rotation and performance pay contribute positively to innovative output; on the other hand, and against our expectation, high rates of internal flexibility do not. Intuitively one would expect that innovative activities are related to high rates of people changing their function or department within the firm. It is therefore puzzling that we do not find a positive coefficient for internal flexibility. Moreover, our estimates give indications that high shares of temporary employees seem to contribute positively to new product sales, while the same variable contributed negatively to the growth of labour productivity in a recent study using the same database (e.g. Kleinknecht et al. 2006). As a qualification, one should remind that our models in table 2 are estimated on one cross-sectional wave of the OSA database only. Future research should exploit the longitudinal character of the OSA database. Despite these qualifications, it is reassuring that our model in table 2 is fairly robust to changes in model specifications. Nevertheless, our result indicate that a firm is able to stimulate its innovative output by means of making use of employees on long-term temporary contract or implement competitive reward systems inside firms.

REFERENCES

- Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal*, 39, 1154–1184. doi:10.2307/256995

- Amemiya, T. (1973). Regression analysis when the dependent variable is truncated normal. *Econometrica*, 41(6), 997–1016. doi:10.2307/1914031
- Audretsch, D., & Thurik, R. (2004). A model of entrepreneurial economy. *International Journal of entrepreneurship. Education*, 2(2), 143–166.
- Beatson, M. (1995). Labour market flexibility. In *Research Series (No.48)*. Sheffield: Employment Department.
- Brown, S. L., & Eisenhardt, K. (1998). *Competing on the edge: strategy as structured chaos*. Boston, MA: Harvard Business School Press.
- Buchele, R., & Christiansen, J. (1999). Employment and productivity growth in Europe and North America: The impact of labour market institutions. *International Review of Applied Economics*, 13(3), 313–332. doi:10.1080/026921799101571
- Cohen, W. M., & Levintal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 128–152. doi:10.2307/2393553
- Coutrot, T. (2003). Innovation and job stability. In *Working Paper*. Paris: Centre D’Etudes Prospectives et D’Informations Internationales.
- Ichniowski, C., & Shaw, K. (1995). Old dogs and new tricks; determinants of the adoption of productivity-enhancing work practices, Brookings Papers: Microeconomics, pp. 1-55.
- Kleinknecht, A., Oostendorp, R. M., Pradhan, M. P., & Naastepad, C. W. M. (2006). Flexible labour, firm performance and the Dutch job creation miracle. *International Review of Applied Economics*, 20(2), 171–187. doi:10.1080/02692170600581102
- Laursen, K., & Foss, N. J. (2003). New Human Resource Management Practices, Complementarities, and the Impact on Innovative performance. *Cambridge Journal of Economics*, 27(2), 243–263. doi:10.1093/cje/27.2.243
- Leonard-Barton, D. (1995). *Wellsprings of knowledge: Building and sustaining the sources of innovation*. Boston, MA: Harvard Business School Press.
- Maddala, G. S. (1983). *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge, UK: Cambridge University Press.
- McGrath, R. G. (2001). Exploratory learning, innovative capacity and managerial oversight. *Academy of Management Journal*, 44, 118–131. doi:10.2307/3069340
- Michie, J., & Sheehan, M. (2003). Labour market deregulation, ‘flexibility’ and innovation. *Cambridge Journal of Economics*, 27, 123–148. doi:10.1093/cje/27.1.123
- Polanyi, M. (1966). *The tacit dimension*. London: Routledge.
- Tidd, J., Bessant, J. R., & Pavitt, K. (2006). *Managing Innovation*. Chichester, UK: Wiley.
- Tobin, J. (1958). Estimation for relationships with limited dependent variables. *Econometrica*, 26(1), 24–36. doi:10.2307/1907382
- Trott, P. (1998). *Innovation management and new product development*. London: Financial Times.
- Tsai, W. (2001). Knowledge transfer in intra-organizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal*, 44, 996–1004. doi:10.2307/3069443
- Van de Zwan, P., Thurik, A. R., & Grilo, I. (2008). (forthcoming). The entrepreneurial ladder and its determinants. *Applied Economics*.
- Verbarg, R. M., & Hartog, D. (2005). Human Resource Management for advanced technology. In Verbarg, R. M., Ortt, J. R., & Dicke, W. M. (Eds.), *Managing Technology and Innovation* (pp. 43–46). London: Routledge.

Verloop, J. (2004). *Insight the Innovation: Managing innovation by understanding the laws of innovation*. Amsterdam: Elsevier Science.

KEY TERMS AND DEFINITIONS

(Degree of) Innovativeness: A categorical variable measuring to what extent new products are 'new to the market'.

Functional Flexibility: The ability of firms to re-allocate labour in their internal labour market, relying on training that allows personnel carrying out a wider range of tasks.

HRM Practices: Human resource management is a strategic approach to managing employment relations which emphasizes that leveraging people's capabilities is critical to achieving sustainable competitive advantage, this being achieved through a distinctive set of integrated employment policies, programmes and practices.

Innovative Output: A two dimensional mea-

sure including innovative productivity and the degree of innovativeness.

Innovative Productivity: The log of new product sales (new to the firm) per employee.

Labour Flexibility: A combined measure of flexibility at firm level including numerical flexibility, functional flexibility and wage flexibility.

Numerical Flexibility: The ability of firms to change the volume of personnel by making use of fixed-term employment contracts, labour hired temporarily, either directly or through temporary work agencies or freelance workers.

Performance Management: A HRM practice concentrating on evaluating, motivating and developing employees' capabilities and performance in order to improve the effectiveness and efficiency of firms.

Recruitment and Selection: A HRM practice aim at hiring the right people for the right position based on observable characteristics such as education and experience.